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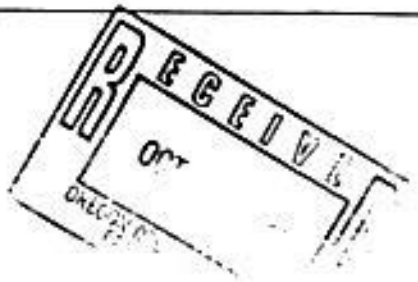
DECLARATION OF THE RECORD OF DECISION



SITE NAME AND LOCATION

Naval Submarine Base, Bangor
Operable Unit 5
Bangor, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected action for Operable Unit (OU) 5 at the Naval Submarine Base (SUBASE), Bangor, in Bangor, Washington, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practical, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). OU 5 consists of Site 5, the demolished former metallurgical laboratory (FML) rubble, with confirmation sampling at the FML original location. This decision is based on the administrative record for the sites.

The lead agency for this decision is the United States Navy. The United States Environmental Protection Agency (EPA) approves of this decision and, with the Washington State Department of Ecology (Ecology), has participated in scoping the site investigations and in evaluating alternatives for remedial action. The State of Washington concurs with the selected remedy.

DESCRIPTION OF THE REMEDY

No action.

DECLARATION

No remedial action is necessary to ensure protection of human health and the environment. A 5-year review is not required.

Using EPA guidelines and the information developed during the site investigation, the Navy evaluated the potential adverse effects to human health and the environment associated with exposure to site chemicals. The potential exposure of workers and residents to chemicals detected at each site was estimated for current and future scenarios. The evaluation, performed according to EPA's NCP and policy guidance, indicated that no unacceptable risks are present at the two sites. This evaluation supports a decision for no action at Operable Unit 5.

Signature sheet for the foregoing SUBASE, Bangor, Operable Unit 5, Remedial Action, Record of Decision between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

E R Lockwood

Captain Ernest R. Lockwood
SUBASE, Bangor, Commanding Officer
United States Navy

9-30-93
Date

Signature sheet for the foregoing SUBASE, Bangor, Operable Unit 5, Remedial Action, Record of Decision between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Gerald Emison
Acting Regional Administrator, Region 10
United States Environmental Protection Agency

9-24-93
Date

Signature sheet for the foregoing SUBASE, Bangor, Operable Unit 5, Remedial Action, Record of Decision between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Carol L. Fleskes

Carol Fleskes, Program Manager
Toxics Cleanup Program
Washington State Department of Ecology

9/27/93
Date

DECISION SUMMARY

1.0 INTRODUCTION

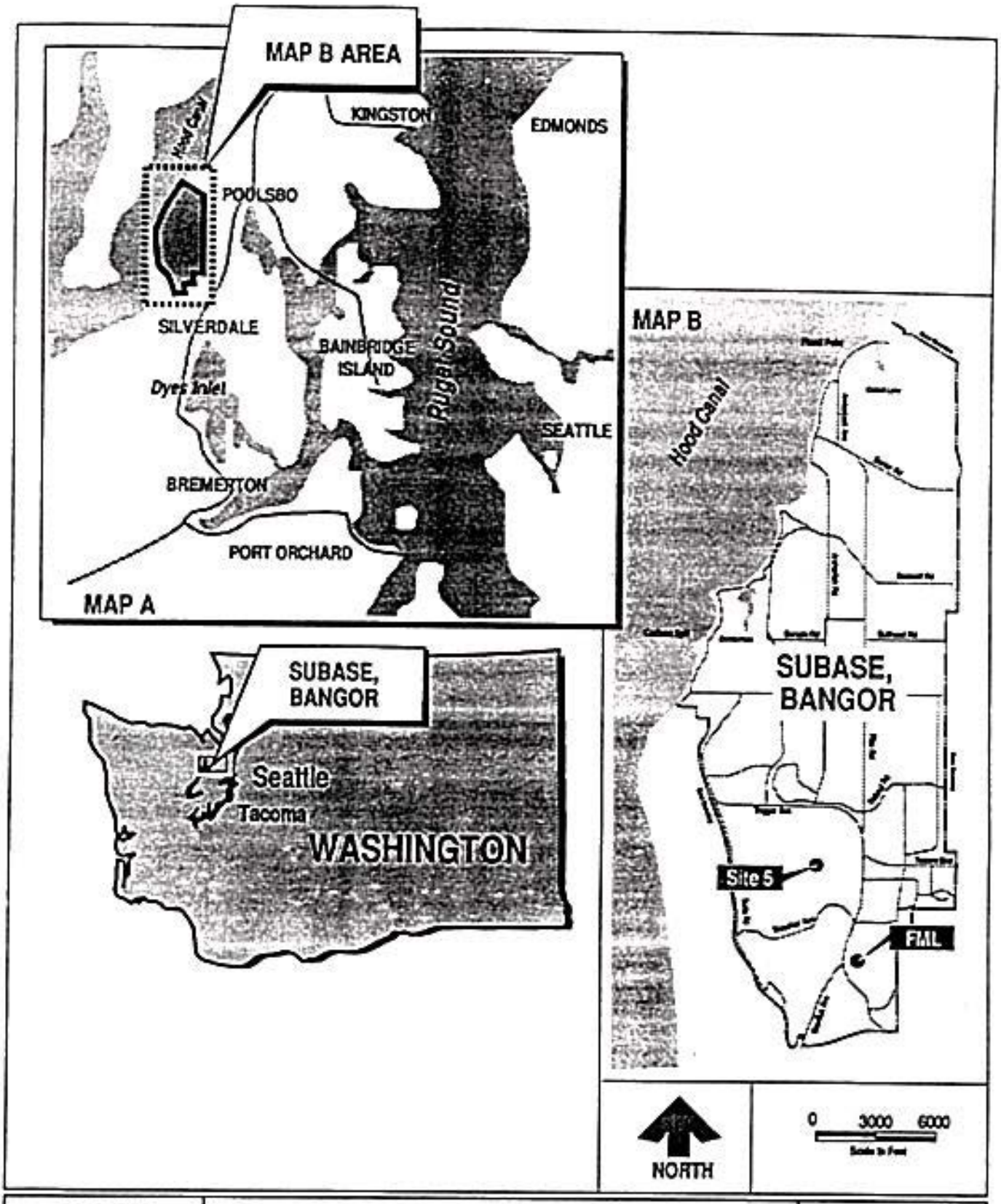
Naval Submarine Base (SUBASE), Bangor was listed on the National Priorities List (NPL) on August 30, 1990. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), the United States Navy (Navy) performed a remedial investigation/feasibility study (RI/FS) to characterize the nature and extent of any residual chemicals of concern. In the case of Operable Unit (OU) 5 at SUBASE, Bangor, the Navy's evaluation of potential adverse effects on human health and the environment indicated no unacceptable risks at the site for either current or future uses.

2.0 SITE NAME, LOCATION, AND DESCRIPTION

SUBASE, Bangor is located in Kitsap County, Washington, approximately 10 miles north of Bremerton on Hood Canal (Figure 1). Land surrounding SUBASE, Bangor is generally undeveloped or supports limited residential use. OU 5 is located in the south-central portion of the base. It consists of Site 5, the disposal location for rubble from the demolished former metallurgical laboratory (FML) (Figure 1). Confirmation samples were taken at the original location of the FML to make sure the area was clean (Figure 2). Mercury was of potential concern at both areas.

The investigation of the FML site consisted of drilling five soil borings to a depth of 15 feet. Soil samples were collected from each boring at intervals of 1.0 to 2.5, 6.0 to 7.5, and 14.0 to 15.5 feet. These samples were analyzed for total metals to determine the possible presence of residual mercury. Concentrations of metals found in FML soil samples were consistent with naturally occurring metals in SUBASE, Bangor soils. Figure 3 shows the location of the soil borings at this FML site.

The remedial investigation of Site 5 included sampling the site soils, stormwater and sediment runoff, downgradient groundwater, and soil vapor. A soil vapor survey was performed in an attempt to pinpoint the burial location of the FML rubble. The soil



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 1 Site Location and Geographic Setting	CTO 0038 SUBASE, Bangor Washington RCO

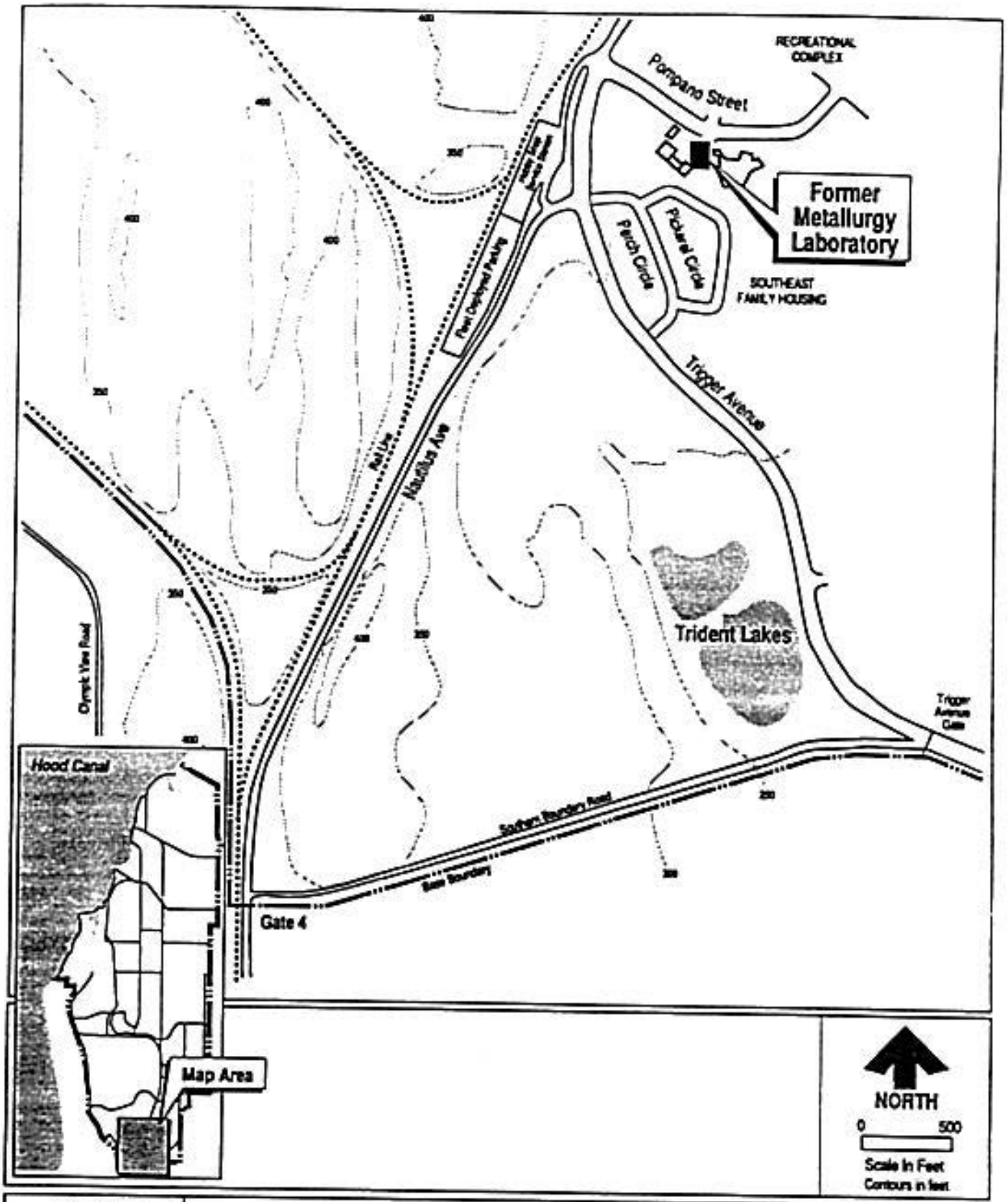


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Figure 2
Site Map, Former Metallurgy Laboratory

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SUBASE, Bangor
Washington
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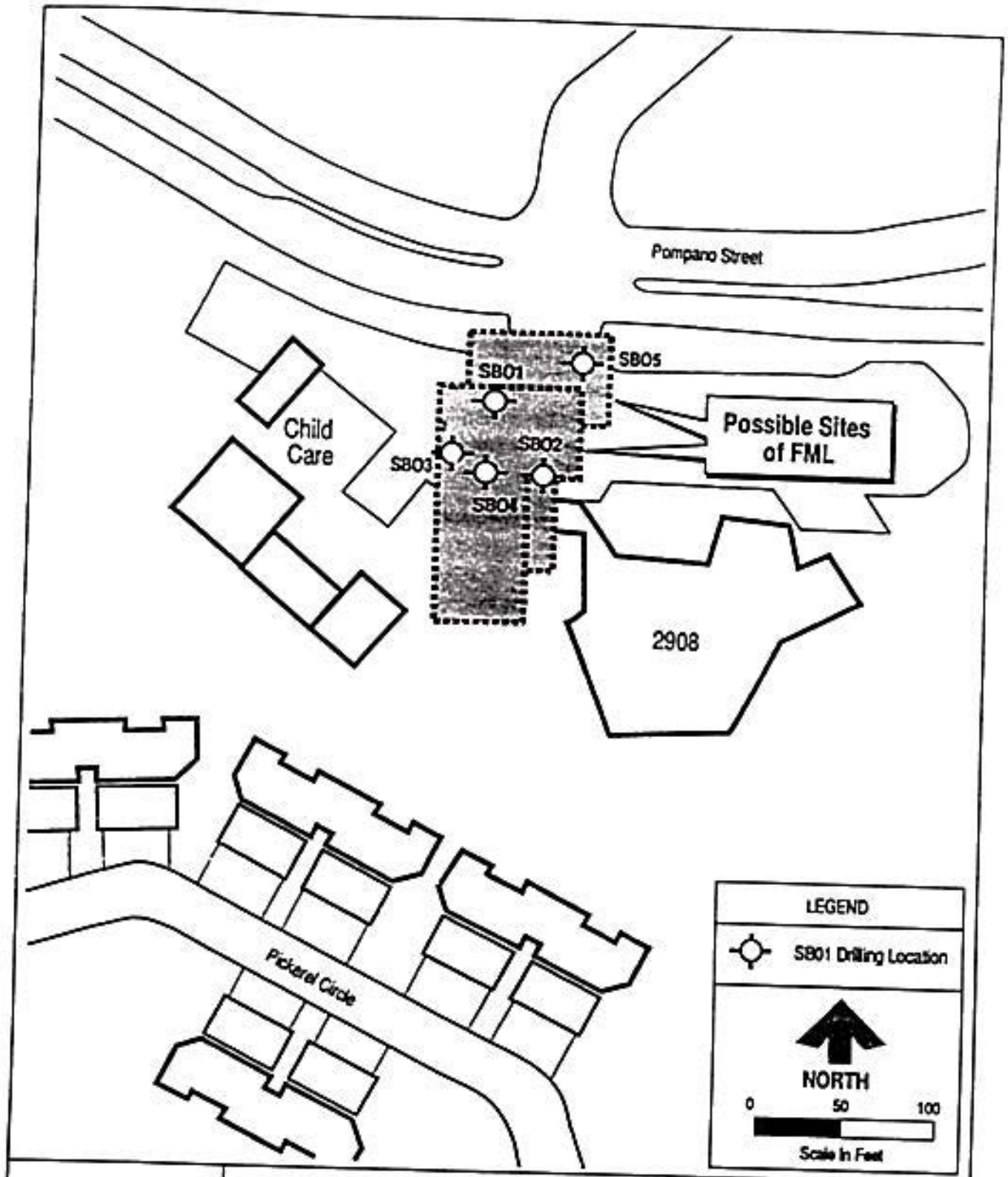


CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 3 Location of Soil Borings at Former Metallurgy Laboratory Site	CTO 0038 SUBASE, Bangor Washington ROD

vapor survey analyzed mercury concentrations in air samples obtained from subsurface soils at various locations on the site. A backhoe was used to excavate possible burial locations identified in the survey, but the FML rubble was not found.

A nested groundwater sampling well was installed downgradient from Site 5. The static groundwater level was approximately 117 feet below ground surface. Groundwater flows are to the northwest in the vicinity of Site 5. No groundwater sampling was performed near the FML. The area around Site 5 generally consists of Vashon Till, which may reach a thickness of up to 40 feet. The till is underlain by Vashon Advance Sand.

2.1 FML SITE

The metallurgy laboratory was torn down in 1973 during construction of the submarine base. The area where the metallurgy laboratory was located was rebuilt as the base's central core area. The area is now a paved parking lot between a child-care center and a base chapel, located between Pompano Street and Pickerel Circle. Since the demolition of the FML, the area has been regraded, paved, and landscaped. Figure 2 shows the site location.

2.2 SITE 5

After the FML was demolished, building rubble was reportedly buried in an area designated for disposal of construction debris. The disposal area is believed to be in the northern portion of the western barricaded railroad siding area, which is located in the south-central part of the base. This area consisted of 20 barricaded railroad sidings. Several years after the initial demolition, the foundation of the FML was reportedly buried in the southern portion of the western barricaded railroad siding area. The abandoned barricaded railroad sidings were filled with construction debris and soil. The exact locations of the buried rubble could not be confirmed by historical records, personnel interviews, or aerial photographs.

The terrain of Site 5 is rolling and uneven, covered with an array of successional, weedy plant species. The soil varies from sand to gravel, and there is no vegetation indicative of moist or wet habitat. The area is surrounded by a dry Douglas fir forest with a relatively low and open understory. Surface water runoff appears to flow unevenly across the entire site. There are no well-established drainage channels, although roadways lying below small berms created by the fill material probably channel stormwater to a small

stream to the south. Figure 1 depicts the general site location and geographic setting of Site 5.

3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

3.1 SUBASE, BANGOR, HISTORY

The U.S. Naval Magazine Facility Bangor was established in 1944 to provide a deepwater transhipment point for ammunition and explosives. It became the primary command for ammunition activities in Puget Sound in 1948.

The primary role of NAD Bangor was to provide transhipment and supply of fleet ordnance, which also included overhaul of ammunition and "disposal" of unserviceable or dangerous ordnance regardless of source (Hart Crowser 1989). Bangor included a segregation and reconditioning facility, where ordnance returned from ships was separated by type and inspected for serviceability. Demilitarization of ordnance at Bangor was begun about 1958 (NEESA 1983).

The Polaris Missile Facility Pacific was added in 1963. Ordnance operations including demilitarization continued and reached a peak between 1966 and 1970 as a result of the Vietnam conflict. With a recall of troops from Vietnam in 1970, the shiploading operation was transferred to Naval Weapons Station (NWS) Concord, and Bangor was linked with Naval Torpedo Station (NTS) Keyport. Concerns over potential environmental hazards were raised at that time, and a variety of studies were undertaken. Demilitarization operations continued on a limited basis until about 1978. Bangor again became an established facility following its selection as the Trident Submarine homeport in 1973.

3.2 HISTORY OF PREVIOUS SITE EVALUATIONS

3.2.1 Assessment and Control of Installation Pollutants

In September 1980, in response to CERCLA, the Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program. The NACIP program is part of the Department of Defense's Installation Restoration Program, which corresponds to EPA's CERCLA program. The objective of the NACIP program is to identify, assess, and control environmental contamination from past hazardous materials storage,

transfer, processing, and disposal operations at Naval facilities. The NACIP program at SUBASE, Bangor superseded the previous ACIP program investigations. In 1981, an initial assessment study (IAS) performed under the NACIP program (NEESA 1983) recommended further investigation of Site 5 to determine whether the site was contaminated.

In 1986, Congress enacted the Superfund Amendments and Reauthorization Act, which brought about changes in the Navy's NACIP program. The Navy was required to modify its existing NACIP program to be consistent with EPA program guidance and terminology.

Rather than develop verification and characterization reports for the sites at SUBASE, Bangor, as had been planned under NACIP, the Navy phased into the EPA's Remedial Investigation/Feasibility Study (RI/FS) program, which involves a phased progression from initial scoping and site characterization to an evaluation of remedial alternatives. A current situation report (CSR) was completed for SUBASE, Bangor in 1989 (Hart Crowser 1989). The CSR indicated that neither the existence nor location of mercury at Site 5 could be confirmed with available soil or water data. However, available data did indicate that mercury was likely to be buried in the vicinity and, unless disturbed, would remain contained below ground. The CSR recommended additional soil testing and stormwater runoff sampling.

On January 29, 1990, the Navy, EPA, and Washington State Department of Ecology (Ecology) signed a cooperative three-party Federal Facility Agreement (FFA) to study and clean up possible contamination at SUBASE, Bangor. The FFA assigned Site 5 to OU 5.

A site investigation (SI) was completed for OU 5 in September 1992 (URS 1992a). The SI conducted a field examination of OU 5 and concluded that mercury vapor was the principal contaminant at Site 5.

An RI/FS was completed for OU 5 in December 1992 (URS 1992b). The RI/FS evaluated whether residual mercury remains in the environment at OU 5, and, if present, whether it posed a threat to human health or the environment. The RI/FS identified no chemicals of concern at the FML site and concluded that mercury concentrations detected at Site 5 do not present a significant risk to human health or the environment.

4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Navy, EPA, and Ecology provided information and solicited comments from the public concerning the proposed plan for remedial action for OU 5 through a public comment period, a response form, and a public meeting and by maintaining repositories of information where residents could review documents and materials related to investigations at SUBASE, Bangor. The community relations plan concerning OU 5 is available for public review in the information repositories at the Central Kitsap Regional Library and the SUBASE, Bangor Branch Library. (Access to SUBASE, Bangor, is restricted to authorized personnel.)

In February 1993, the Navy, EPA, and Ecology published *The Proposed Plan for Operable Unit 5* (URS 1993). A notice of availability of the proposed plan and public comment period was placed in *The Sun* (Bremerton) on February 24, 1993. In addition, the proposed plan was placed in the administrative record and mailed to all on the mailing list. SUBASE, Bangor periodically issues fact sheets discussing remedial activities at all operable units at the installation. The public comment period on the proposed remedial action extended from February 24 to March 26, 1993.

A public meeting to discuss remedial action and obtain comments was held on March 4, 1993, at the Olympic View Community Center in Silverdale, Washington. There were 37 people in the audience (including Navy, EPA, and Ecology personnel and a court reporter) and 6 people on the panel. Seven comments were received. Responses to public comments are contained in the Responsiveness Summary (Appendix A).

Repositories of information are maintained at the following locations:

Central Kitsap Regional Library
1301 Sylvan Way
Bremerton, Washington
(206) 377-7601

Bangor Branch Library
Naval Submarine Base, Bangor
(206) 779-9274

The administrative record is on file with:

Engineering Field Activity, Northwest
1040 N.E. Hostmark Street
Olympic Place II
Poulsbo, Washington
(206) 396-5984

5.0 SCOPE AND ROLE OF OPERABLE UNITS

Two NPL sites are located at SUBASE, Bangor. The first is Bangor Ordnance Disposal, Site A (OU 1), which was listed on the NPL on July 22, 1987. On August 30, 1990, the remainder of SUBASE, Bangor—including an additional six operable units comprising 20 known or suspected hazardous waste sites—was listed on the NPL. This record of decision addresses one of these operable units, OU 5, which consists of Site 5.

The risk assessment for noncancer and cancer risks at OU 5 shows that the original FML site and Site 5 present no significant current or potential threats to human health or the environment and do not warrant further action.

6.0 SUMMARY OF SITE CHARACTERISTICS

This section presents an overview of site contamination and potential routes of exposure posed by conditions at the two sites.

The FML site was used for testing brass projectile shell casings. The casings were coated with mercurous nitrate and heated. The procedure reduced and volatilized the mercury, which then condensed in the walls of the metallurgical laboratory building. It is estimated that during the years of operation (from approximately 1958 to 1973), roughly 100 pounds of mercurous nitrate were consumed in the testing procedure, retained within the building, and could be present in the rubble of the FML (NEESA 1983; Spencer 1983).

Site 5, as described in the initial assessment study (NEESA 1983), the current situation report (Hart Crowser 1989), and the Federal Facility Agreement, is the disposal location for the FML rubble, formerly designated Building 274. Rubble from the building was

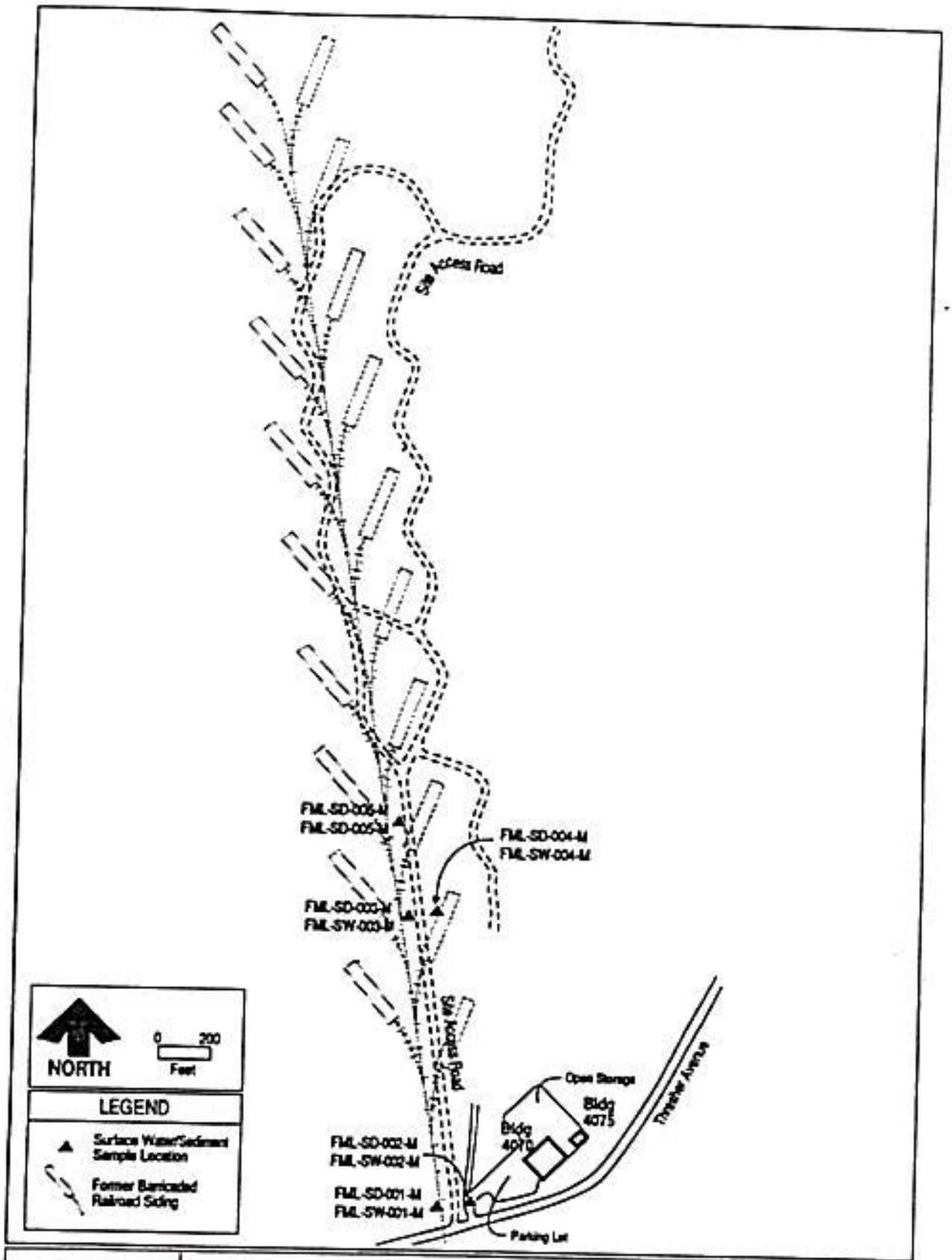
reportedly disposed of in the former barricaded railroad sidings located in the south-central portion of the base. Aerial photographs of the Site 5 vicinity suggest that major disposal and grading activities began at the site between 1975 and 1977 (Hart Crowser 1989). However, historical data, aerial photographs, and site investigations did not reveal the exact location of the FML rubble within the former barricaded railroad sidings.

Data on the chemical characteristics of the Site 5 environment prior to the current investigation consisted of one surface water sample collected in 1983 and two surface water composites, two surficial stream sediment composites, and five soil samples collected from test pits in 1987. The 1987 surface water and stream sediment samples were obtained by compositing individual samples collected from five ditch locations on either side of the access road through the site. These samples were collected during a storm sufficient to generate sheet-flow runoff.

The surface water sample collected in 1983 is believed to have been collected from the surface water drainage ditch at the site's downstream (southern) boundary. This sample was submitted for mercury analysis. Because of inadequate documentation of the analytical result, the reported value may not be valid. The laboratory report did not document the analytic methods and units of reporting, and the validity of this data is questionable. Surface water samples collected subsequent to 1983 were gathered in an attempt to duplicate the results of the Navy's 1983 sampling that tentatively identified mercury in surface water.

Water samples collected in 1987 were submitted for the determination of 84 constituents including metals, ordnance, volatile organics, pesticides, herbicides, and polychlorinated biphenyls (PCBs). Surficial sediment samples were analyzed for total mercury. The surface water samples did not detect mercury above a level of 0.1 μg/L. Furthermore, neither surficial stream sediment nor soil samples collected during the assessment exhibited mercury concentrations above background levels for Puget Sound soils.

Five other metals (beryllium, chromium, copper, lead, and nickel) were detected in the surface water. The presence of these other metals in Site 5 surface waters, sediments, and soils is consistent with the presence of metal wastes from refuse not associated with the FML rubble. The measured levels of these metals were similar to those reported in regional residential runoff (Hart Crowser 1989). Figure 4 shows the surface water and sediment sampling locations at Site 5.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 4 Surface Water/Sediment Sampling Locations at Site 5	CTO 0038 SUBASE, Bangor Washington ROD

In the 1980s, nine test pits were excavated to the base of fill materials and into Vashon Till in various parts of the abandoned barricaded sidings. Five soil samples were selected for chemical analysis in places where rubble—possibly from the FML—was found. No mercury above background concentrations was found in any of the test pit samples. Cadmium and zinc were present in Site 5 soils at levels higher than normally occur in Puget Sound soils. The incidence of these metals in Site 5 soils is consistent with the presence of metal wastes not associated with the FML rubble.

In 1992, a soil vapor survey was conducted with field instrumentation during the site investigation of Site 5 (URS 1992a). Soil vapor samples taken at a depth of 10 to 15 feet below ground surface indicated the presence of mercury vapor.

The remedial investigation subsequently conducted at the FML site and Site 5 (URS 1992b) consisted of the following components and findings:

- **FML Site**

  - Identifying the original location of the metallurgy laboratory through aerial photographs, interviews, and construction maps

  - Drilling five soil borings to 15 feet below the asphalt surface. (Fifteen samples [three from each boring] were collected and analyzed for total mercury. In addition, selected samples were analyzed for ordnance compounds.)

  Findings: Mercury concentrations in FML site soils ranged between 0.04 mg/kg and 0.08 mg/kg in 14 of the 15 samples. Only one sample (SB05, at a depth of 1 to 2.5 feet) at 0.63 mg/kg exceeded background concentrations.

- **Site 5**

  - Reviewing aerial photographs and historical records in an attempt to locate the metallurgy laboratory rubble disposal area within the abandoned barricaded sidings

  - Sampling surface water runoff and sediments in an attempt to duplicate earlier sampling by the Navy that had tentatively identified the presence of mercury

- Conducting a soil vapor survey in an attempt both to detect the presence of mercury in the barricaded railroad sidings and to locate the FML rubble. (Figure 5 shows the boundaries of the soil vapor survey at Site 5.)

- Excavating test pits at the locations with the highest mercury vapor detections in an attempt to locate the buried FML rubble (based on field screening with a mercury vapor sensor, soil samples were taken from the test pit, and sent to selected laboratories for analysis)

- Conducting a followup soil mercury vapor survey at selected locations to determine whether the mercury vapor concentrations detected during the initial survey, using field instrumentation, represented localized accumulations of mercury vapor or whether mercury vapor was widely dispersed within fill materials

- Conducting a third soil mercury survey consisting of long-term (1 to 8 hour) pumping using sorbent tubes, followed by laboratory analysis

- Sampling groundwater collected from a previously installed downgradient nested well pair. (Two samples were collected. Groundwater was found in two aquifers: one shallow and the other at sea level. Well F-MW-43 was screened near the base of the shallow aquifer from 157 feet to 172 feet below ground surface [bgs]. Well F-MW-43S was screened near the top of the shallow aquifer from 118 feet to 123 feet bgs. Figure 6 shows the location of the nested well pair.)

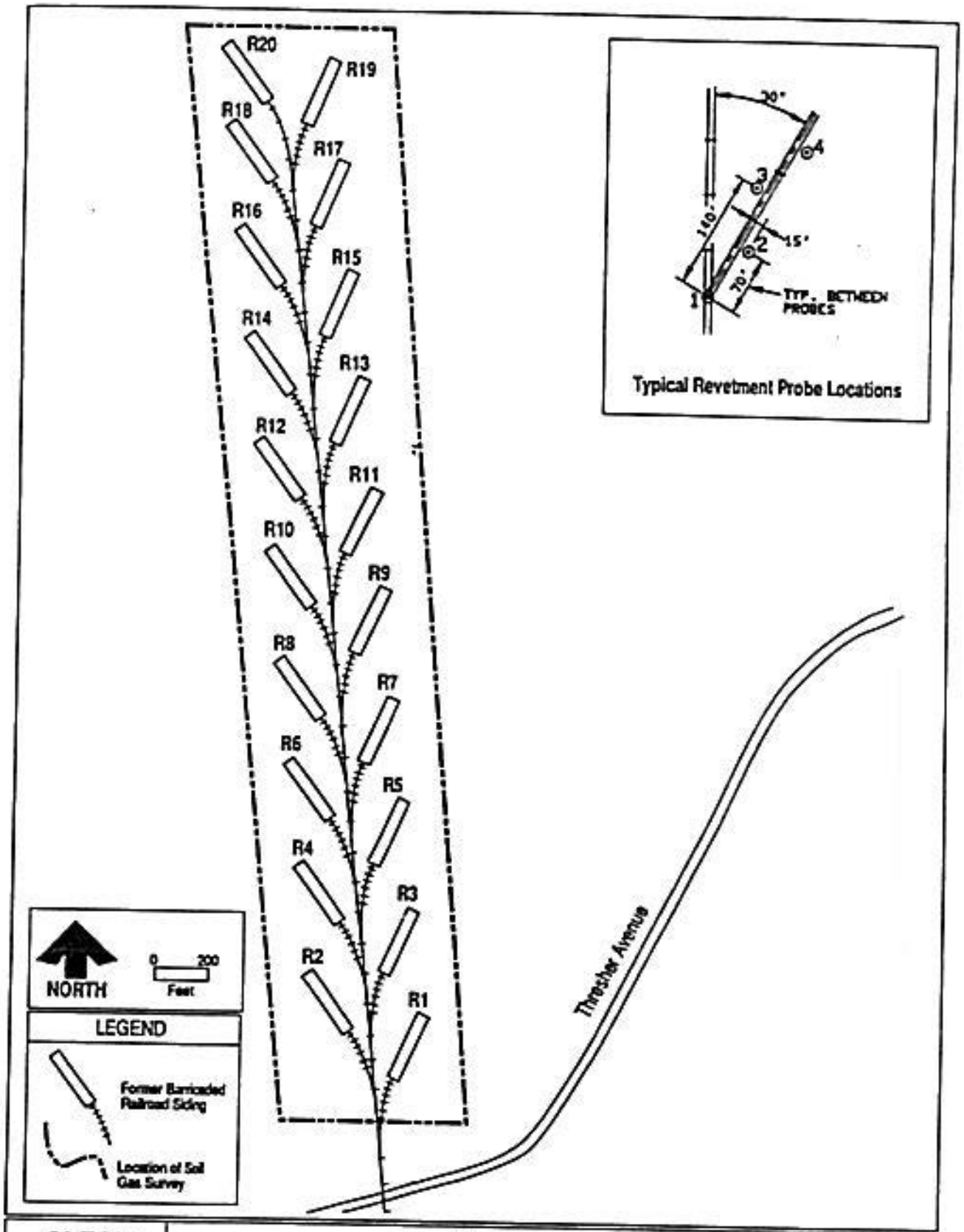


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Figure 5
Boundaries of Soil Vapor Survey In Old Barricaded Railroad Sidings at Site 5

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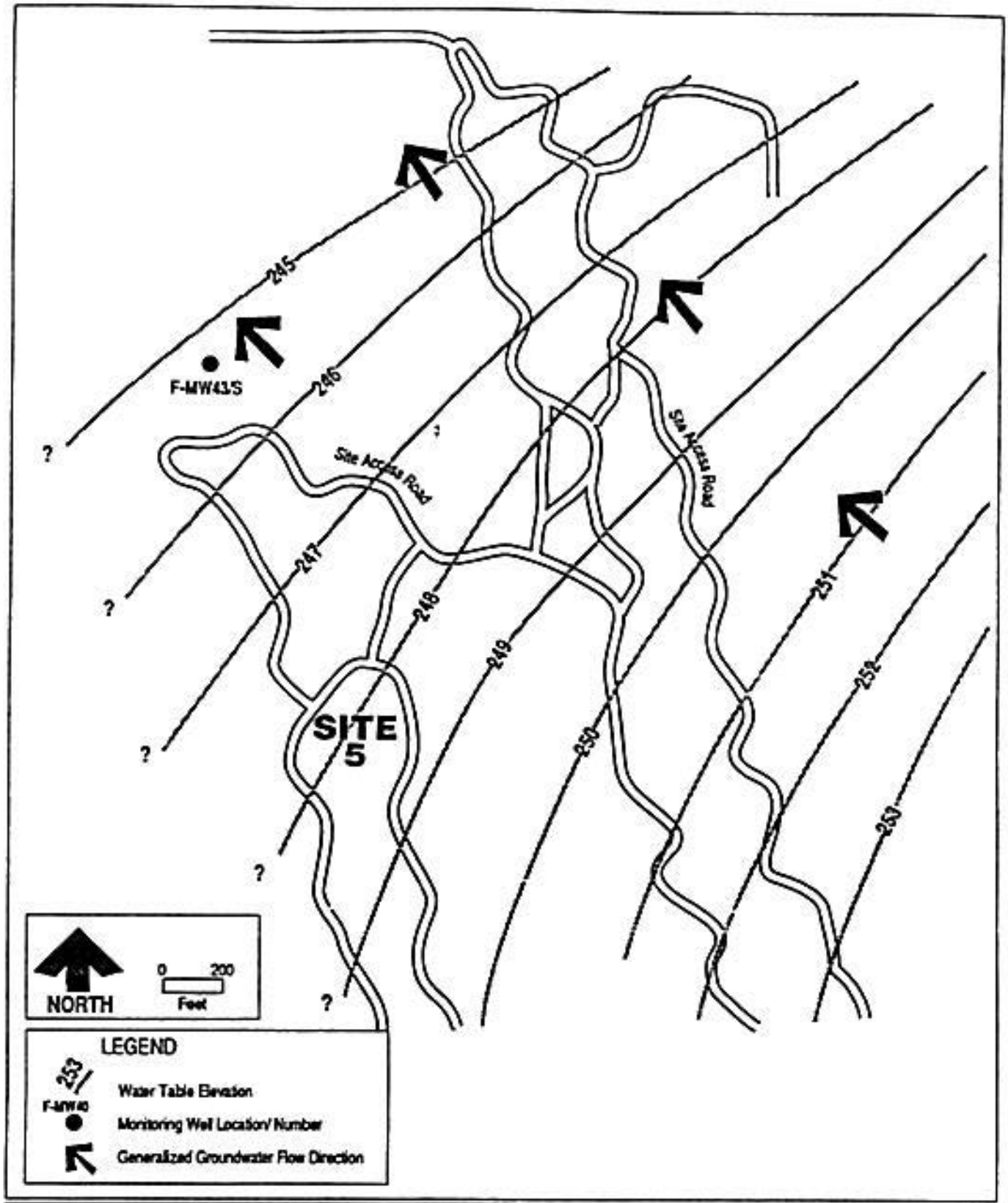

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 6 Location of Monitoring Wells and Shallow Aquifer Water Table Elevation Contour Map Modified from Hart Crowser 1992	CTO 0038 SUBASE, Bangor Washington ROD

Findings:

Surface water runoff and sediments. No dissolved metals detected in surface water samples exceeded EPA maximum contaminant levels (MCLs). Concentrations of beryllium detected in stormwater sediments exceeded background surface soil concentrations but are within the range of subsurface soil concentrations.

Soil vapor surveys. All three soil vapor surveys indicated the presence of mercury in soil vapors. The two screening-level surveys were used as a predictive tool for subsequent sampling. The laboratory results from the long-term survey were used to analyze risks at the site, which were determined to be within the EPA's acceptable risk range.

Soils surveys. Mercury was detected in all test pit samples between 0.018 and 0.097 mg/kg. The data indicated that the concentrations of mercury detected at Site 5 are at or slightly above natural background concentrations. Mercury data from Site 5 are compared with background concentrations in Table 1.

Table 1
Comparison of Observed Mercury Levels at Site 5 to Natural Background Concentrations at SUBASE, Bangor

Matrix	[illegible]	[illegible]
Surface soil	0.08	0.075
Subsurface soil	0.08	0.097

To summarize the results of the remedial investigation, mercury was not selected as a chemical of potential concern (COPC) for Site 5 soil or water because the maximum concentrations in the site soil were below the risk-based screening concentration (RBSC) and because mercury was not detected in water. (Section 7.0 discusses RBSC screening.) Even if mercury were present in water at half the detection limits, the concentrations would not exceed the RBSC. Because mercury was detected in soil vapor samples taken at a depth of 10 to 15 feet below ground surface at Site 5, there is the potential for mercury to migrate through the soil profile and volatilize into the ambient air. However, no source of mercury was found during the site investigation (URS 1992a). Therefore, the lateral and vertical extent of contamination and site-specific fate and transport cannot be addressed.

7.0 SUMMARY OF SITE RISKS

The results of soil analyses taken at the FML site were compared with background levels, State of Washington Model Toxics Control Act (MTCA) Method B values, and EPA Region 10 RBSCs to determine whether the detected concentrations of chemicals exceeded screening concentrations. No chemicals of concern exceeded these screening levels at this site; therefore, a human health risk assessment was not performed.

The results of mercury analysis of samples from Site 5 were compared with SUBASE, Bangor, naturally occurring levels and EPA Region 10 RBSCs to determine whether the detected concentrations of mercury exceeded screening concentrations. No concentrations of mercury in soil exceeded EPA Region 10 RBSCs. No mercury was detected in the groundwater or surface water. The risk assessment developed for a hypothetical future residence at Site 5 indicated that indoor air concentrations of mercury would be below the level of concern and would not present an unacceptable health risk.

The following were considered as potential pathways of migration for possible contamination at Site 5: movement of mercury vapors through the soil into the ambient air, migration of residual mercury in surface water runoff and groundwater movement, uptake of residual mercury in vegetation at the site, and bioaccumulation of mercury at increasingly higher levels of the food chain.

7.1 HUMAN HEALTH RISK ASSESSMENT

7.1.1 FML Site

- **Background Concentrations**

Table 2 compares soil metals data from the FML area with naturally occurring concentrations. The evaluation shows that the levels of arsenic, beryllium, chromium, lead, and nickel detected in the soils were at or below naturally occurring concentrations in soils at SUBASE, Bangor, thus eliminating these elements as COPCs.

Table 2
Comparison of Observed FML Soil Metals
Concentrations to Naturally Occurring Concentrations

Metals	Naturally Occurring Concentrations (mg/kg)		Observed Subsurface Soil Concentrations (mg/kg)	
	Surface Soil	Shallow Subsurface Soil	Minimum	Maximum
Arsenic	3.57	2.52	0.62	1.6
Beryllium	0.27	1.03	0.57	1
Chromium	27	33	13	25.8
Lead	19	5	0.85	3.6
Mercury	0.08	0.05	0.04	0.63
Nickel	55	91	38.5	51.7

Note: Shading under mercury indicates maximum concentration exceeds background.

- **RBSC Comparisons**

The maximum concentration of mercury detected in the soil at the FML site is below the EPA Region 10 RBSC and the State of Washington MTCA Method B concentration (Table 3).

- **Results**

Based on this evaluation, no COPCs were identified at the FML site.

7.1.2 Site 5

According to the OU 5 work plan (BVWST 1991) and the CSR, Volume I (Hart Crowser 1989), historical data identified mercury as the principal waste constituent of concern at Site 5. This concern was supported by the detection of mercury vapor during the site investigation (URS 1992a). This investigation served as a screening tool, indicating the need for longer term mercury vapor testing to produce laboratory-quality results. Laboratory-quantified mercury vapor concentrations were obtained from sorbent tubes containing Hydrar used for the long-term survey (URS 1992b).

Table 3
Comparison of Observed Soil Concentrations with EPA Region 10 RBSCs and Washington MTCA Method B Proposed Cleanup Levels

Chemicals of Potential Concern	Max Soil Concen (mg/kg)	Exposure Route	RfD (mg/kg/day)	EPA Region 10 RBSCs for Soil (mg/kg)		Washington MTCA Method B Proposed Cleanup Levels for Soil (mg/kg)	RBSC or MTCA Exceedance
				Cancer 10E-7	Noncancer HQ=0.1		
Mercury	0.63	Inhalation*	8.60E-05*	NA	637	24	No

NA = not available
*Risk-based calculation based on soil ingestion is not appropriate for elemental mercury since inhalation exposure is of greater concern for this metal. The RBSC for mercury was derived assuming 0.27 m^3 air/kg body weight/day (EPA 1991, Appendix III) and 50 µg particulates/m^3 air (ambient air quality standard for PM10).
*The reference dose (RfD) for inorganic mercury was used because elemental mercury is the volatile form. This RfD was calculated from a previously listed chronic reference concentration (EPA 1992a). However, this RfD for inorganic mercury is currently under review by the EPA.

As stated in Section 5.0, the risk assessment for noncancer and cancer risks at OU 5 shows that Site 5 presents no significant current or potential risks to human health or the environment.

A statistical analysis was conducted on data from the matrices sampled at Site 5. The mean analytical values, the maximum observed values, and the 95-percent upper confidence limit values are shown in Table 4.

Table 4
Statistical Results of Mercury (Hg) in Matrices Sampled at Site 5

Matrix	Species	N	Units	RBSC	Mean	Maximum	UCL95
Surface soil	Hg, total	5	mg/kg	8.2	0.075	0.075	0.075[a]
Subsurface soil	Hg, total	16	mg/kg	8.2	0.040	0.097	0.050[b]
Soil gas	Hg, vapor (March)	61	mg/m³	NA	0.173	>0.999	0.248
	Hg, vapor (June)	34	mg/m³	NA	0.336	>0.999	0.467
	Hg, vapor (8 hours)	9	mg/m³	NA	0.002	0.004	0.003[a]
	Hg, vapor (1 hour)	9	mg/m³	NA	0.003	0.010	0.005
Surface water	Hg, total	5	µg/L	1.1	0.100	0.100	0.100[a]
	Hg, dissolved	5	µg/L		0.100	0.100	0.100[a]
Groundwater	Hg, total	2	µg/L	11.0	0.500	0.500	0.500[a]

N = number of samples
UCL95 = upper 95-percent confidence limit
NA = not available
[a]Mercury was not detected in any samples; results used in risk assessment were less than the detection limit.
[b]Exposure point values were used to estimate risk.

Note: Shaded values indicate the values used for comparison with the SUBASE, Bangor, naturally occurring levels and EPA Region 10 RBSCs.

- **Background Comparisons**

Naturally occurring concentrations of metals in surface and subsurface soil were calculated according to the methodology provided by Ecology (1992). The data indicate that the concentrations of mercury detected in the soil at Site 5 are at or slightly above naturally occurring concentrations. Table 5 compares mercury data from Site 5 with naturally occurring concentrations.

Table 5
Comparison of Observed Mercury Levels at Site 5 to Naturally Occurring Concentrations at SUBASE, Bangor

Matrix	Naturally Occurring Concentration of Total Mercury (mg/kg)	Maximum Observed Concentration of Total Mercury (mg/kg)
Surface soil	0.08	0.075
Subsurface soil	0.08	0.097

- **RBSC Comparisons**

As shown in Table 6, mercury concentrations in soil were well below the EPA Region 10 RBSC, corresponding to a hazard quotient (HQ) of 0.1. The hazard quotient is a quantity resulting from the comparison of an observed concentration of a chemical with the established reference dose. If the results are greater than 1.0, exposure to that chemical is considered to be of potential concern.

Mercury was not detected in any samples of groundwater or surface water. Even if it is assumed that mercury is present in these samples at one-half the detection limit, these concentrations are substantially below the RBSCs for mercury in these media. The concentrations presented in Table 6 are only estimates of the levels of mercury based on the contract-required quantitation limit (CRQL). CRQLs are levels down to which laboratory procedures are required to detect specific chemicals.

EPA does not provide RBSCs for air (EPA 1991). Consequently, comparison of mercury concentrations in site air with RBSCs was not possible.

Table 6
Comparison of Results of Mercury Sampling at Site 5 to EPA Region 10 RBSCs

Matrix	Species	RfD[a] (mg/kg/day)	Exposure Route	HQ	RBSC[b]	Total Hg Maximum Concentration	Matrix	RBSC Exceedance
Soil	Elemental mercury	3.00E-04	Ingestion	0.1	8.2 mg/kg	0.075 mg/kg 0.097 mg/kg	Surface soil Subsurface soil	No No
Water	Methyl mercury	3.00E-04	Oral	0.1 1.0	1.10 µg/L 11.0 µg/L	0.100 µg/L 0.500 µg/L	Surface water Groundwater	No[c] No[c]
Soil gas	Elemental mercury	3.00E-04 mg/m³	Inhalation	Not applicable	Not applicable	0.004 mg/m³	Soil gas	Not applicable

[a]Taken from EPA 1992a. Ingestion and inhalation toxicity criteria for mercury have been withdrawn from the Integrated Risk Information System (IRIS).
[b]Calculated according to EPA 1991.
[c]All total mercury results in groundwater and surface water were nondetects. The maximum concentrations listed for these samples are half the contract-required quantitation limit (CRQL) of the laboratory method used. Levels below CRQL are "nondetects" but not necessarily zero.

- **Results**

Only mercury concentrations in the air were evaluated in the risk assessment; mercury was not selected as a chemical of potential concern for Site 5 soil or water. No unacceptable risks were found for mercury at Site 5.

7.2 RISK CHARACTERIZATION

7.2.1 FML Site

Arsenic, beryllium, chromium, lead, and nickel concentrations are at or below naturally occurring concentrations in soils at SUBASE, Bangor. Mercury concentrations are below EPA Region 10 RBSCs. Mercury is also below the State of Washington MTCA Method B value. Furthermore, under current conditions, the asphalt surface in the vicinity of the child-care center minimizes direct exposure to the underlying soil, reducing potential risk.

7.2.2 Site 5

Mercury levels in the soil samples are below SUBASE, Bangor, naturally occurring levels and EPA Region 10 RBSC levels. Mercury levels in soils are also below the State of Washington MTCA Method B levels. Using an estimated indoor air concentration (IAC) of mercury, noncancer risks were calculated for a hypothetical future resident who might be exposed to mercury vapors. This calculation requires comparing the estimated IAC of mercury with an acceptable, health-protective level. A reference concentration (RfC) of 3×10^{-4} mg/m^3 has been used to represent a safe exposure level. However, the EPA has withdrawn the RfC for mercury from its IRIS chemical toxicity database (U.S. EPA 1992a) pending review by an EPA work group. For this evaluation, EPA Region 10 requested that the withdrawn RfC, which is still listed in the Health Effects Assessment Summary Tables (U.S. EPA 1992b), be used as an interim toxicity value until an updated RfC becomes available.

A predictive model was developed to estimate the concentration of mercury in the indoor air of a hypothetical residence built on Site 5. This model estimated the flux, or transport, of mercury vapor from the soil through the foundation wall and into the ambient air of the residence. The model used for this task was the Hensley and Schofield model, which was based on a radon soil gas transport model. Dividing the estimated IAC for mercury (URS 1992b) with the RfC yields an HQ. Thus, 8×10^{-7} mg/m^3 divided by 3×10^{-4} mg/m^3 is equal to an HQ of 3×10^{-3}, a value below 1.0, the

standard level of concern. If a house were built on Site 5, mercury would not present an unacceptable health risk.

In addition, because occupational exposures are typically less than residential exposures (due primarily to reduced time spent on site), inhalation of mercury vapors by workers at Site 5 would not pose an unacceptable risk. The maximum concentrations of mercury vapor in air yield acceptable risks for noncancer effects for both future residential and occupational exposure.

7.2.3 Uncertainty Analysis

The general trend of the risk characterization performed at Site 5 and the FML site was conservative. An overestimation of risk is expected to result.

- **Analytical Results**

The results for Site 5 water data are derived from samples reporting undetected concentrations at the CRQL. In this case, the mean, maximum, and 95-percent upper confidence limit value are equal. This situation is acceptable because the CRQLs are below screening concentrations.

Most analytical methods produce results with an accuracy range of 10 to 20 percent (McKown et al. 1984).

- **Screening Concentrations**

RBSCs were compared to the maximum observed levels of mercury found at these sites. Because of the limited sampling and analysis activities at Site 5 and the FML site and the potential for error propagated during field investigations, the maximum detected value for any chemical in a solitary sample requires careful interpretation. The screening method is conservative, with a potential to overestimate risk.

A number of uncertainties are inherent in the assumptions and calculations related to indoor mercury concentrations. First, it is conservative to assume that a residence will be built on Site 5. It is not anticipated that the site will change to include residential use. In addition, the site is composed of building fill materials, and excavation of the area and construction of a residence on this site is highly unlikely. It is also conservative to assume that the building foundation and compacted soils surrounding the building will

not attenuate the flux of mercury from the soils into the indoor air. The RfC for inhaled mercury is somewhat uncertain because the EPA has withdrawn it from the IRIS chemical toxicity database (U.S. EPA 1992a). The RfC used in this risk assessment is based on a no-effects level observed in several long-term human studies and includes an uncertainty, or safety, factor of 30. Based on the number of conservative assumptions included in our analysis, it is highly unlikely that indoor air concentrations of mercury would exceed health-protective levels.

7.3 ECOLOGICAL RISK ASSESSMENT

7.3.1 FML Site

The area of the original FML is a paved parking lot; no ecological risk is posed by this site. No ecological evaluation was conducted at this site.

7.3.2 Site 5

- **Site Species**

The forest in the vicinity of Site 5 provides good habitat for a variety of animal species, including deer, and probably is a refuge for animals that are transient foragers in the rubble area.

No threatened or endangered species were observed at Site 5. Bald eagles, which are protected under the Bald Eagle Protection Act of 1940 and the Endangered Species Act of 1973, may perch on trees in the surrounding forest. No endangered or threatened plant species are known to be found at SUBASE, Bangor.

- **Exposure Pathways and Receptors**

Having no known biological function, mercury is toxic in an inorganic form, but has greater toxicity after transformation into organic forms such as methyl mercury. Mercury can accumulate at higher levels in the food chain, eventually posing greater environmental risks to top-level predators than to organisms at the base of the food chain.

The following pathways and receptors were selected for evaluation of mercury at Site 5:

- Root uptake from soils by weedy herbaceous plants
- Ingestion of vegetation by a herbivorous small mammal (Townsend's vole)
- Incidental ingestion of soils by a small burrowing mammal (Townsend's vole)
- Predatory consumption of small mammals by coyotes

Townsend's voles and coyotes are common at SUBASE, Bangor.

- **Summary and Conclusions**

HQs were determined for receptor species: voles and coyotes. HQs greater than 1.0 indicate a potential stress on exposed organisms. There are no risks greater than 1.0 to voles or coyotes from exposure to mercury in soil at Site 5. Risks to voles and coyotes through ingestion of soil, water, vegetation, and prey were not above 1.0 for either ionic or total mercury. Risk for exposure to mercury vapor inhalation by burrowing animals was below 1.0 when a toxicity reference value for humans was used.

7.4 FUTURE RISK SCENARIOS

It was assumed in the risk characterization that present data are representative of data that would be collected in the future. It is anticipated that the soil vapor concentrations of mercury would be reduced over time through volatilization. Because no source area for mercury has been firmly identified in subsurface soils, no additional significant release of mercury is expected.

8.0 THE SELECTED REMEDY

The selected remedial action at OU 5 is the no-action alternative. The risk assessment for noncancer and cancer risks at OU 5 shows that the FML site and Site 5 present no significant current or potential threats to human health or the environment and do not warrant further action.

Concentrations of all metals found in the FML site soils, including mercury, were at or below naturally occurring concentrations in soils at SUBASE, Bangor. Soil concentrations of metals were also below the State of Washington's acceptable concentrations for those metals with published values of acceptable concentrations. In addition, the asphalt surface covering the original FML area minimizes direct exposure to the underlying soil, reducing any potential risk. On the basis of these findings, no compounds were selected for risk evaluation at the FML.

Risks for mercury in any environmental medium at Site 5 were determined to be within the National Contingency Plan's acceptable risk range.

Based on the information currently available, the Navy, EPA, and Ecology conclude that the existing conditions at the two sites are protective of human health and the environment, and a no-action decision is warranted.

9.0 REFERENCES

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